RESEARCH DEPARTMENT

BAND III EXPERIMENTAL TRANSMISSIONS FROM HOLME MOSS

Report No. K-111

(1956/13)

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SUMMARY

The report shows the results of a field strength survey from an experimental Band III transmitter at Holme Moss using a frequency of 187·5 Mc/s.

It is shown that up to distances of from approximately 40 to 65 miles (65–100 km), with an e.r.p. of 100 kW and depending on the ground profile, the median field strength values on Band III would tend to be higher than those for the same e.r.p. on Band I. Beyond these distances the reverse would be the case. The field strength for which the Band I and III values were the same was approximately 0·5 mV/m.

A comparison between horizontal and vertical polarisation in Band III showed that, although the positions of the median field strength contours were the same, the range of variation of field strength was, in most cases, less when using vertical polarisation.

Measurements and observations of multipath interference have been made and this interference appears to be more widespread than on Band I. It is expected that the reduction of the interference will be less difficult than on Band I because more directional receiving aerials can conveniently be erected.

1. INTRODUCTION.

This report has been compiled from the results of a field strength survey of a Band III transmitter sited at Holme Moss.

As this was the first survey to be undertaken in this band by the B.B.C. Research Department, measurements were made in rather more detail than has been usual on v.h.f. surveys. Measurements were included of both horizontally and vertically polarised transmissions over a limited area and of multipath interference in some of the principal towns in the area.

Although the primary object of this survey was to determine the service area, additional information was obtained on the general propagation effects in Band III. This information will be of use in estimating the service from future Band III transmitter sites.

2. GENERAL.

The transmitter used for the measurements described in this report was installed at the Band I television transmitter site at Holme Moss with the aerial on the existing mast at a height of 700 ft (213·6 m) above ground level.

The field strength survey was made on a 187·5 Mc/s transmission, square-wave modulated at 1 kc/s and radiated from a directional horizontally polarised aerial with a mean effective radiated power of 950 W in the direction of maximum radiation and reduced by 3 dB at ± 25° from the maximum. It was therefore necessary to make the survey in sectors of approximately 50° and to allow for the difference in e.r.p. over this arc.

A batwing (superturnstile) omnidirectional aerial was used as the receiving aerial in conjunction with a v.h.f./u.h.f. mobile receiver developed for the purpose. The mid-point of the aerial was 11 ft 5 in. (3·5 m) above ground level and continuous record charts of field strength were made on a recording milliammeter using the technique normally used for site tests and v.h.f. surveys.

All field strength values quoted in this report, except where otherwise stated, have been corrected for an e.r.p. of 100 kW and for a receiving aerial height of 30 ft (9·2 m) above ground level. To correct for a receiving aerial height of 30 ft (9·2 m) a multiplying factor of 2·6 was applied to the values measured at 11 ft 5 in. (3·5 m) except where the propagation conditions were such that no height gain could be expected. Receiving aerial height-gain measurements were made in most towns to confirm the assumptions made.

In order to compare horizontal with vertical polarisation, measurements were made in one sector on each polarisation in turn.

The transmitter at Holme Moss was converted to pulse transmission for observations and measurements of multipath interference. A pulse repetition frequency of 1 kc/s and a pulse width of 0·5 μsec, with a peak e.r.p. of 30 kW, was used. The received signal was displayed on a cathode ray oscilloscope so that measurements of both the amplitude and the delay of the echoes relative to the direct ray could be made.

3. RESULTS.

3.1. Field Strength Contour Maps.

A map of the whole area showing the position of the field strength contours from 100 mV/m to 0·1 mV/m is shown in Fig. 1. This map is based mainly on measurements in towns and villages and is intended to present the median value of field strength available in such populated areas; the field strength received in open country is likely to be in excess of those indicated by the map. The median value of field strength in each town or village was assessed by analysis of the chart record. The contours on the map have been drawn using these median values and the accuracy is such that the actual value in any particular town or village would lie within ± 10 dB of that indicated. The analysis also showed that 80% of the populated areas investigated would receive a median value lying within ± 5 dB of that indicated by the map. Because of the large variation of field strength, even over very short distances, due to screening and terrain effects, the particular value of field strength at any location in a town or village may of course differ from the value indicated by the map by a considerably larger amount. The range of such variation is indicated in Table 1 which shows the maximum, mean and minimum values as measured in all towns.

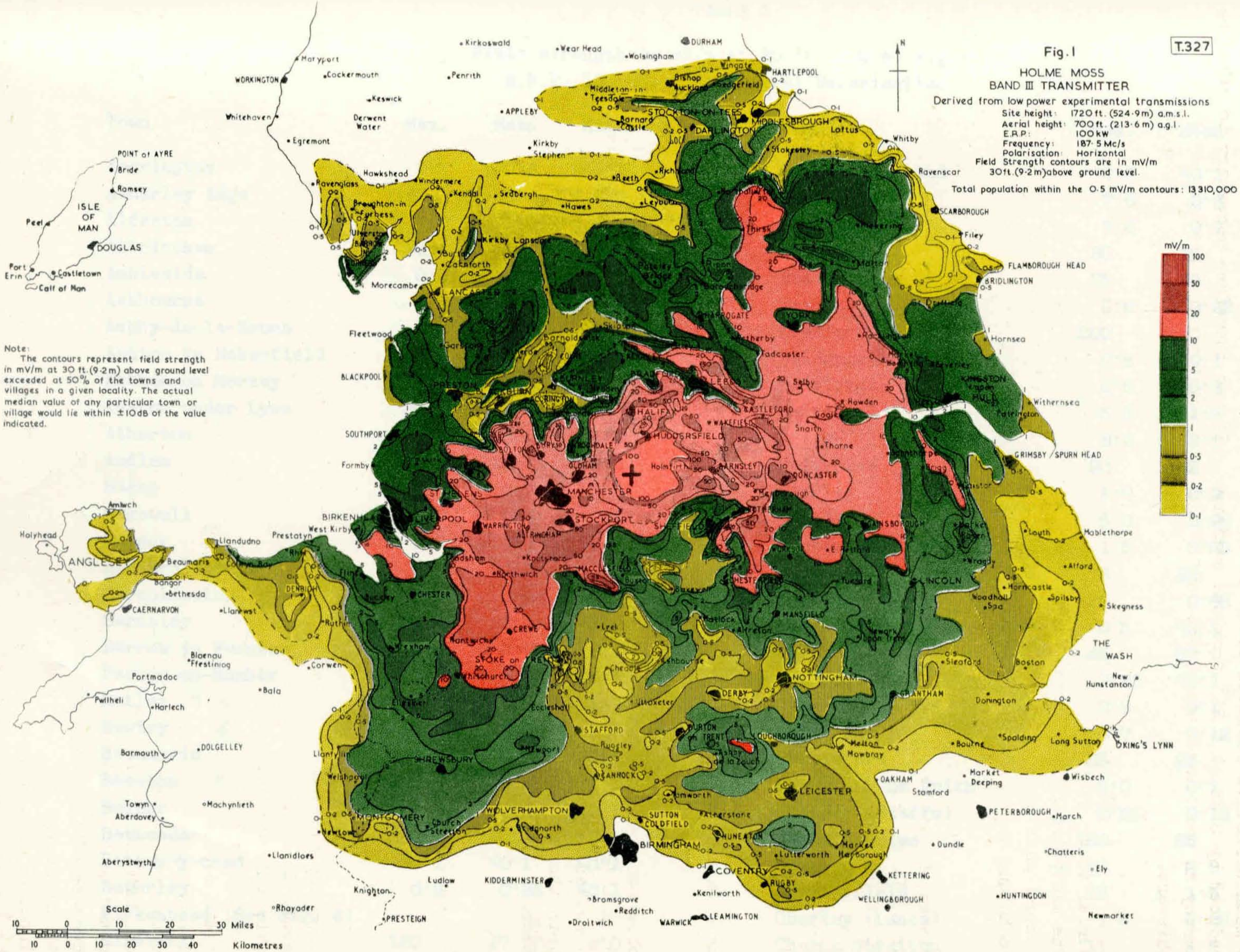
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Fig. 1
HOLME MOSS
BAND III TRANSMITTER
Derived from low power experimental transmissions
Site height: 1720 ft. (524·9 m) a.m.s.l.
Aerial height: 700 ft. (213·6 m) a.g.l.
E.R.P.: 100 kW
Frequency: 187·5 Mc/s
Polarisation: Horizontal
Field Strength contours are in mV/m
30 ft. (9·2 m) above ground level.
Total population within the 0·5 mV/m contours: 13,310,000
mV/m
100
50
20
10
5
2
1
0·5
0·2
0·1
Note:
The contours represent field strength in mV/m at 30 ft. (9·2 m) above ground level exceeded at 50% of the towns and villages in a given locality. The actual median value of any particular town or village would lie within ±10 dB of the value indicated.
Scale
10 0 10 20 30 Miles
10 0 10 20 30 40 Kilometres
ISLE OF MAN
DOUGLAS
ANGLESEY
DURHAM
HARTLEPOOL
MIDDLESBROUGH
STOCKTON-ON-TEES
DARLINGTON
SCARBOROUGH
FLAMBOROUGH HEAD
BRIDLINGTON
LANCASTER
Morecambe
Fleetwood
BLACKPOOL
SOUTHPORT
LIVERPOOL
MANCHESTER
HUDDERSFIELD
STOCKPORT
DONCASTER
LINCOLN
GRIMSBY / SPURN HEAD
THE WASH
KING'S LYNN
NOTTINGHAM
DERBY
LEICESTER
SHREWSBURY
WOLVERHAMPTON
BIRMINGHAM
COVENTRY
KETTERING
PETERBOROUGH
CHESTER
CAERNARVON
CREWE
STOKE on TRENT
KIDDERMINSTER
LEAMINGTON
WORKINGTON

TABLE 1

Field strength in mV/m at 30 ft (9·2 m) a.g.l.
E.R.P. 100 kW. Horizontal Polarisation

Town	Max.	Mean	Min.
Accrington	2·5	0·4	<0·1
Alderley Edge	130	30	6·5
Alfreton	7·0	1·5	0·3
Altrincham	70	45	18
Ambleside	0·3	0·1	<0·1
Ashbourne	2·5	0·3	<0·1
Ashby-de-la-Zouch	4·0	0·45	0·13
Ashton in Makerfield	50	30	12
Ashton on Mersey	110	30	12
Ashton under Lyne	30	7·5	1·0
Atherton	60	16	4·0
Audlem	40	10	3·0
Bacup	2·0	0·7	0·2
Bakewell	1·0	0·3	0·13
Bangor	1·5	0·1	<0·1
Barnard Castle	0·5	<0·1	<0·1
Barnoldswick	0·7	0·28	<0·1
Barnsley	75	22	1·0
Barrow in Furness	4·5	0·75	0·1
Barton-on-Humber	3·0	0·33	<0·1
Batley	10	5·0	1·8
Bawtry	10	5·0	2·0
Beaumaris	1·2	0·5	<0·1
Beeston	1·5	0·25	0·1
Belper	2·0	0·5	0·1
Bethesda	<0·1	<0·1	<0·1
Bettws-y-coed	<0·1	<0·1	<0·1
Beverley	0·9	0·25	<0·1
Birkenhead (See Fig. 4)			
Birstall	120	17	3·0
Bishop Auckland	0·3	<0·1	<0·1
Blackburn	7·0	0·6	<0·1
Blackpool	7·0	0·7	0·1
Bolsover	80	15	5·0
Bolton	75	30	3·0
Boston	0·6	0·22	0·1
Bradford	200	30	1·2
Bridgnorth	0·5	0·1	<0·1
Bridlington	2·0	0·3	<0·1
Brierfield	5·0	1·2	0·25
Brigg	8·0	3·5	1·5
Brighouse	90	43	14
Burnley	6·0	0·9	0·1
Burslem	5·0	0·26	<0·1
Burton-on-Trent	1·5	0·25	<0·1
Bury	75	30	3·0
Buxton	20	0·65	0·15
Caernarvon	0·5	<0·1	<0·1
Caistor	45	27	8·0
Cannock	0·23	<0·1	<0·1
Capel-Curig	0·3	0·1	<0·1
Carnforth	0·7	0·12	<0·1
Castleford	85	26	3·0
Chapel En Le Frith	2·0	0·7	0·3
Cheadle (Staffs)	0·55	0·13	<0·1
Cheadle Hulme	150	65	20
Chester	12	2·0	0·18
Chesterfield	15	1·5	0·2
Chorley (Lancs)	1·5	0·28	<0·1
Church Stretton	11	4·5	2·1

Town	Max.	Mean	Min.
Clayton Le Moors	3·0	1·3	0·3
Cleckheaton	25	11	4·0
Cleethorpes	0·8	0·2	<0·1
Clitheroe	5·0	0·9	0·1
Coalville	10	2·5	0·45
Colne (Lancs)	4·0	0·38	<0·1
Colwyn Bay	6·0	1·4	0·15
Congleton	35	5·2	0·75
Conway	1·5	0·65	0·13
Cottingham (Yorks)	1·6	0·6	0·25
Crewe	40	12	2·0
Crowle	20	12	5·0
Dalton in Furness	0·3	<0·1	<0·1
Darlington	3·0	0·5	0·1
Darwen	0·8	0·15	<0·1
Denbigh	6·0	1·7	0·23
Derby	3·5	0·53	<0·1
Dewsbury	250	60	30
Doncaster	50	8·5	1·5
Great Driffield	2·0	0·45	0·15
Earlestown	45	11	2·5
Easingwold	30	12	5·0
East Retford	40	7·0	0·6
Eccles	80	28	4·0
Eccleshall	6·0	1·0	0·65
Elland	45	11	1·3
Ellesmere	15	1·5	0·6
Ellesmere Port	18	8·7	2·2
Farnworth	100	25	5·0
Fenton (Staffs)	10	0·53	<0·1
Filey	0·1	<0·1	<0·1
Fleetwood	4·0	0·9	0·25
Flint	20	7·8	1·8
Formby	6·0	2·6	0·7
Frodsham	10	4·5	2·0
Gainsborough	20	3·5	0·6
Glossop	275	8·5	1·2
Goole	30	10	3·0
Grantham	2·5	0·5	0·1
Grimsby	2·0	0·4	0·1
Guisborough	0·2	<0·1	<0·1
Halifax	110	61	3·3
Hanley	2·0	0·28	<0·1
Harrogate	50	3·5	0·3
Haslingden	1·3	0·45	0·2
Heanor	3·0	1·1	0·3
Hebden Bridge	1·5	0·35	0·1
Heckmondwike	160	60	5·0
Helmsley	1·0	0·22	<0·1
Hessle	12	2·2	0·5
Heysham	4·0	0·9	0·2
Heywood	90	25	10
Hinckley	3·0	0·5	<0·1
Hindley	10	3·5	1·0
Holmes Chapel	70	23	7·0
Holyhead	0·25	<0·1	<0·1
Horbury	75	40	10
Horncastle	1·3	0·25	<0·1
Hornsea	3·0	0·7	0·25
Horsforth	100	35	10
Horwich	7·0	1·4	0·3
Hoylake	7·0	1·5	0·4
Hucknall Torkard	1·5	0·4	0·1
Huddersfield	400	100	4·0
Hull	6·5	1·1	0·25
Hyde	60	8·0	0·5
Ilkeston	3·0	0·5	0·13
Ilkley	0·7	0·2	<0·1

Town	Max.	Mean	Min.
Keighley	6·0	0·6	0·1
Kendal	0·15	<0·1	<0·1
Kirkham (Lancs)	6·3	1·3	0·25
Kirton in Lindsey	50	18	5·0
Knaresborough	8·0	1·9	0·5
Knottingley	20	7·0	2·5
Knutsford	70	30	10
Lancaster	1·0	<0·1	<0·1
Leeds (See Fig. 5)			
Leek	5·5	0·8	0·12
Leicester	1·6	0·25	<0·1
Leigh (Lancs)	50	8·0	2·0
Lincoln	40	2·4	0·2
Littleborough (Lancs)	2·0	0·7	0·3
Liverpool (See Fig. 4)			
Liversedge	240	63	26
Llanberis	<0·1	<0·1	<0·1
Llandudno	1·5	0·7	0·15
Llanfair-P.G.	0·42	0·2	<0·1
Llanfyllin	0·2	<0·1	<0·1
Llangollen	0·6	0·18	<0·1
Long Eaton	3·0	0·4	0·1
Longridge	40	10	1·5
Longton (Staffs)	3·5	0·5	<0·1
Loughborough	5·0	0·8	0·3
Louth	0·3	0·1	<0·1
Lytham St. Annes	4·0	1·0	0·25
Mablethorpe	0·6	0·2	<0·1
Macclesfield	60	4·0	0·5
Malpas	21	8·0	3·5
Malton	3·0	1·3	0·5
Manchester (See Fig. 3)			
Mansfield	5·0	2·0	0·2
Market Drayton	7·0	2·5	1·0

Town	Max.	Mean	Min.
Market Harborough	0·35	0·23	<0·1
Market Rasen	9·0	1·3	0·3
Market Weighton	20	7·0	2·0
Marple	140	50	5·0
Matlock	1·0	0·33	0·12
Melbourne (Derby	7·0	0·9	0·35
Melton Mowbray	0·25	<0·1	<0·1
Menai Bridge	0·23	0·18	0·12
Mexborough	50	12	3·0
Middleton (Lancs)	40	14	5·0
Middlesborough	1·0	0·2	<0·1
Middlewich	35	11	4·0
Millom	0·7	0·22	<0·1
Mirfield	50	20	4·0
Mold	8·0	3·7	0·6
Morecambe	4·0	0·5	0·1
Morley (Yorks)	20	4·0	1·0
Nantwich	45	13	2·0
Nelson	5·0	0·3	<0·1
Newark	7·0	1·1	0·25
Newcastle under Lyme	50	1·2	<0·1
New Mills (Derby)	100	17	3·5
Newport (Salop)	0·85	0·35	0·12
Northallerton	6·0	1·6	0·6
Northwich	50	10	2·0
Nottingham	6·0	0·33	<0·1
Nuneaton	1·0	0·17	<0·1
Oakengates	6·0	1·5	<0·1
Oakham	0·15	<0·1	<0·1
Oldham	100	24	4·0
Ollerton (Notts)	20	10	2·0
Ormskirk	7·0	1·5	0·3
Ossett	180	60	10
Oswaldtwistle	3·0	0·25	<0·1

Town	Max.	Mean	Min.
Oswestry	6·0	1·7	0·6
Otley	2·0	0·7	0·15
Overton (Flint)	10	3·0	1·0
Padiham	4·0	0·5	0·15
Penistone	100	45	15
Penmaen Mawr	0·35	0·26	0·1
Pentraeth	<0·1	<0·1	<0·1
Pickering	12	3·0	0·6
Pocklington	25	9·0	3·0
Pontefract	30	9·0	2·0
Poulton Le Fylde	5·0	1·6	0·6
Prescot	14	3·2	0·7
Prestatyn	8·0	2·0	1·2
Preston	7·0	0·66	0·1
Pudsey	75	22	8·0
Queensferry	15	6·7	4·2
Radcliffe	60	14	2·0
Ramsbottom	10	3·0	0·6
Rawtenstall	4·5	0·8	0·15
Redcar	0·6	<0·1	<0·1
Rhyl	9·0	1·1	0·2
Richmond	1·0	0·15	<0·1
Ripley (Derby)	5·0	2·2	0·55
Ripon	4·5	1·2	0·25
Rishton	7·0	2·0	0·40
Rochdale	100	10	1·0
Rotherham	80	5·0	0·5
Royton	30	9·0	3·5
Rugby	0·5	0·12	<0·1
Rugeley	1·5	0·25	<0·1
Runcorn	40	19	3·5
St. Asaph	0·7	0·4	0·1
St. Helens	60	7·5	0·8
Sale	150	40	10
Sandbach	30	11	6·0
Scarborough	1·0	0·13	<0·1
Scunthorpe	30	18	1·5
Selby	45	7·0	2·0
Settle	2·5	0·35	<0·1
Shaw	12	2·8	1·2
Sheffield (See Fig. 2)			
Shifnal	1·4	0·3	<0·1
Shipley (Yorks)	7·0	1·4	0·4
Shrewsbury	6·5	1·6	0·2
Skegness	0·3	0·1	<0·1
Skipton	3·0	0·9	0·2
Sleaford	1·6	0·3	<0·1
Snaith	50	12	3·0
Southport	9·0	1·8	0·2
Spilsby	0·5	0·25	<0·1
Stafford	0·9	0·25	<0·1
Stalybridge	10	2·5	0·5
Stockton-on-Tees	1·5	0·4	<0·1
Stocksbridge	200	30	1·0
Stoke-on-Trent	9·0	0·52	<0·1
Stokesley	1·3	0·55	0·2
Stone (Staffs)	0·17	<0·1	<0·1
Stretford	50	18	10
Sutton in Ashfield	7·0	1·5	0·2
Swadlincote	19	4·5	0·5
Swinton (Lancs)	50	21	6·0
Swinton (Yorks)	20	10	3·0
Tadcaster	15	4·5	1·0
Tamworth	2·0	0·13	<0·1
Thirsk	14	3·0	0·6
Thornaby on Tees	1·5	0·3	<0·1
Thorne	35	13	4·0
Todmorden	4·0	0·5	0·15

Town	Max.	Mean	Min.
Tunstall (Staffs)	12	1·2	<0·1
Tuxford	25	5·0	1·0
Tyldesley	40	12	2·0
Ulverston	2·0	0·5	0·1
Uppingham	0·7	0·2	0·1
Uttoxeter	2·3	0·5	0·1
Wainfleet All Saints	0·5	0·15	<0·1
Wakefield	120	27	6·0
Warrington	100	20	3·2
Wath-upon-Dearne	40	8	1·5
Wellington	5·3	1·5	0·4
Welshpool	5·0	0·45	<0·1
Wem	8·0	2·6	0·8
West Hartlepool	1·5	0·15	<0·1
Wetherby	9·0	2·2	0·4
Whaley Bridge	34	7·5	2·2

Town	Max.	Mean	Min.
Whitby	0·7	<0·1	<0·1
Whitchurch	19	3·7	0·45
Whitworth	4·0	1·2	0·5
Widnes	22	12	3·6
Wigan	15	3·7	0·6
Wilmslow	35	18	7·0
Windermere	0·2	<0·1	<0·1
Winsford	60	12	3·0
Winterton	7·0	2·5	1·0
Wirksworth	2·0	0·5	0·1
Withernsea	2·0	0·55	0·12
Worksop	15	5·0	2·0
Wragby (Lincs)	5·0	1·2	0·4
Wrexham	7·0	2·2	0·4
Yeadon	120	35	5·0
York	30	5·0	0·7

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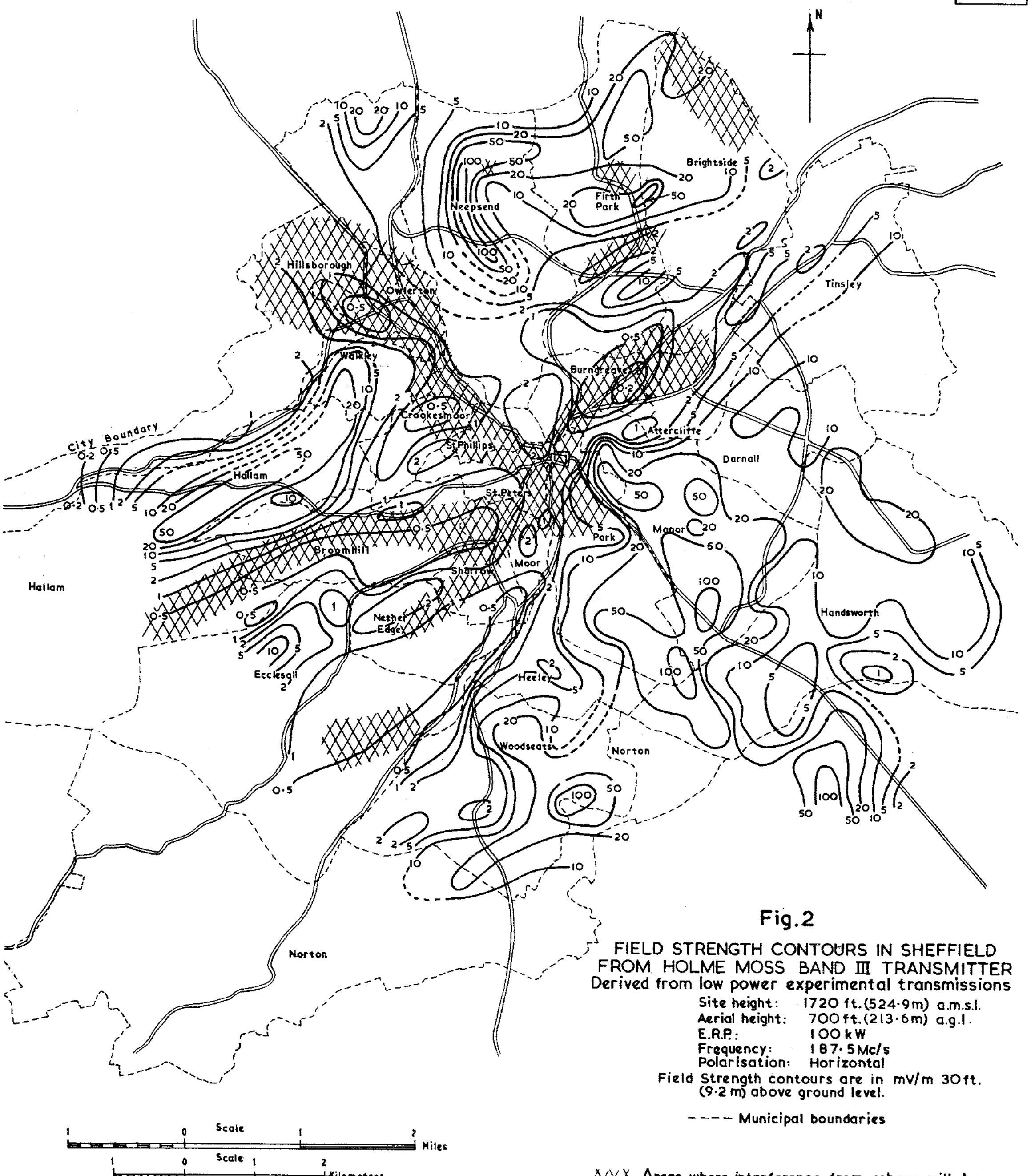

Fig.2

FIELD STRENGTH CONTOURS IN SHEFFIELD
FROM HOLME MOSS BAND III TRANSMITTER
Derived from low power experimental transmissions

Site height:	1720 ft.(524·9m) a.m.s.l.
Aerial height:	700 ft.(213·6m) a.g.l.
E.R.P.:	100 kW
Frequency:	187·5 Mc/s
Polarisation:	Horizontal

Field Strength contours are in mV/m 30 ft. (9·2 m) above ground level.

---- Municipal boundaries

Areas where interference from echoes will be serious (at least 2 echoes less than 10 dB below the direct signal.)

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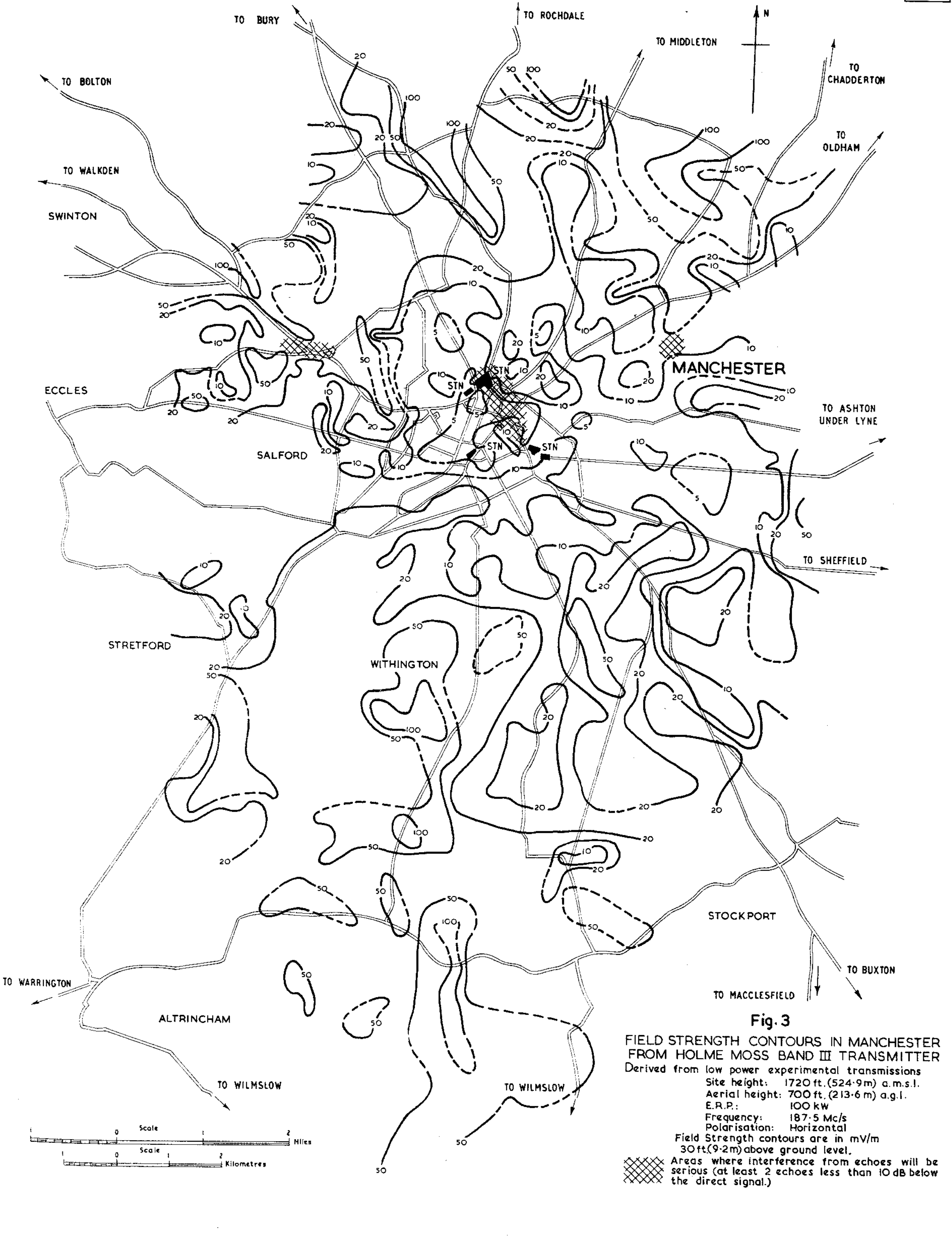

Fig. 3

FIELD STRENGTH CONTOURS IN MANCHESTER FROM HOLME MOSS BAND III TRANSMITTER

Derived from low power experimental transmissions

Site height: 1720 ft. (524·9 m) a.m.s.l.
Aerial height: 700 ft. (213·6 m) a.g.l.
E.R.P.: 100 kW
Frequency: 187·5 Mc/s
Polarisation: Horizontal

Field Strength contours are in mV/m 30 ft. (9·2 m) above ground level.

Areas where interference from echoes will be serious (at least 2 echoes less than 10 dB below the direct signal.)

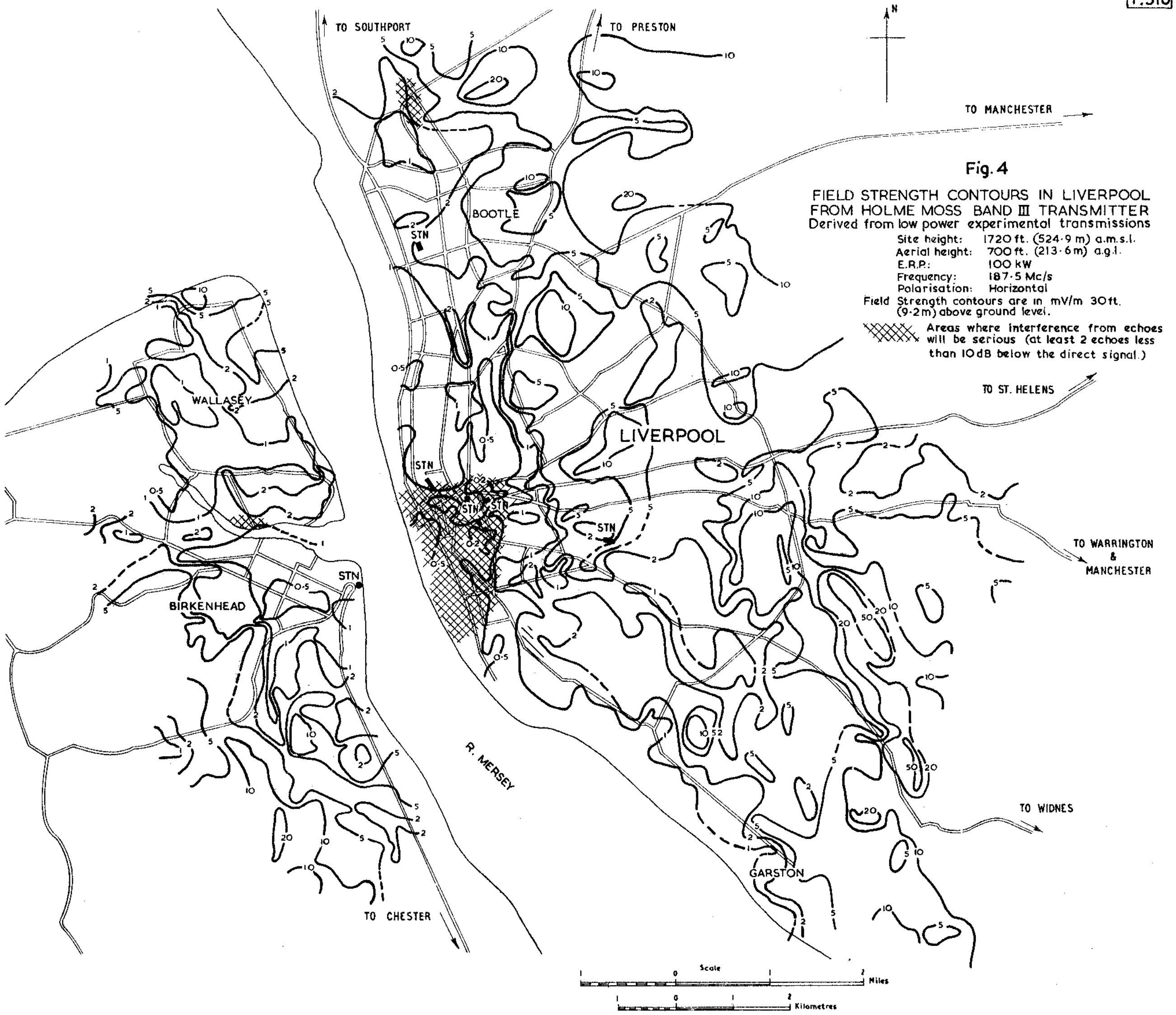

Fig. 4

FIELD STRENGTH CONTOURS IN LIVERPOOL FROM HOLME MOSS BAND III TRANSMITTER

Derived from low power experimental transmissions

Site height:	1720 ft. (524·9 m) a.m.s.l.
Aerial height:	700 ft. (213·6 m) a.g.l.
E.R.P.:	100 kW
Frequency:	187·5 Mc/s
Polarisation:	Horizontal

Field Strength contours are in mV/m 30 ft. (9·2 m) above ground level.

Areas where interference from echoes will be serious (at least 2 echoes less than 10 dB below the direct signal.)

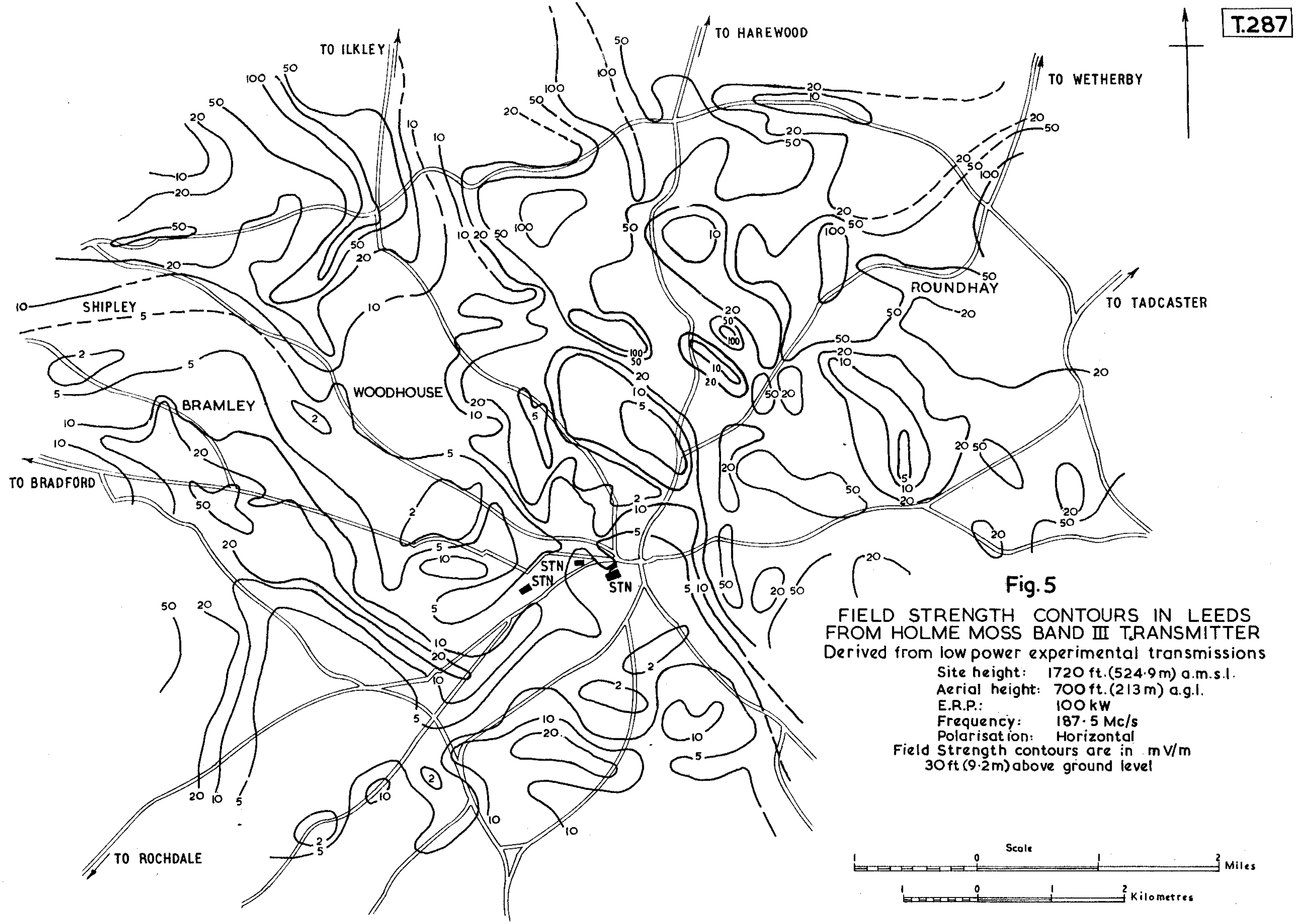

Fig. 5

FIELD STRENGTH CONTOURS IN LEEDS FROM HOLME MOSS BAND III T. TRANSMITTER

Derived from low power experimental transmissions

Site height: 1720 ft. (524·9 m) a.m.s.l.
Aerial height: 700 ft. (213 m) a.g.l.
E.R.P.: 100 kW
Frequency: 187·5 Mc/s
Polarisation: Horizontal
Field Strength contours are in mV/m 30 ft (9·2 m) above ground level

More detailed field strength contour maps have been made for each of the larger cities in the area and are shown in Figs. 2, 3, 4 and 5. These contours show the median field strength value in any locality in the city although local variation may amount to ± 6 dB in the extreme cases.

3.2. Local Variation Factor.

At v.h.f. the value of field strength at any location may be appreciably affected by comparatively small obstructions, such as trees, houses, etc., and by small variations in ground level in the vicinity of the receiving site. To obtain an accurate estimate of the service provided by a transmitter at these frequencies the variation of field strength due to these factors must be taken into account. In any area throughout which no large changes of propagation path occur the scatter around the median value of field strength is due to the above causes and follows very closely a log normal distribution. The degree of scatter is, of course, dependent on the size and incidence of occurrence of the obstacles, etc., in the immediate vicinity. It has been suggested by a Working Party of Study Group V of the C.C.I.R. that this value shall be called the "local variation factor" and defined "the local variation factor for a given area is the ratio (normally expressed in decibels) between the values of field strength exceeded at 50% and at 90% of all the individual receiving points within that area".

In the following two examples the values of local variation factor were obtained from field strength measurements taken in open country and in a built-up area from a continuous "cruise" of 1·25 miles (2 km) over which no large change in propagation path occurs.

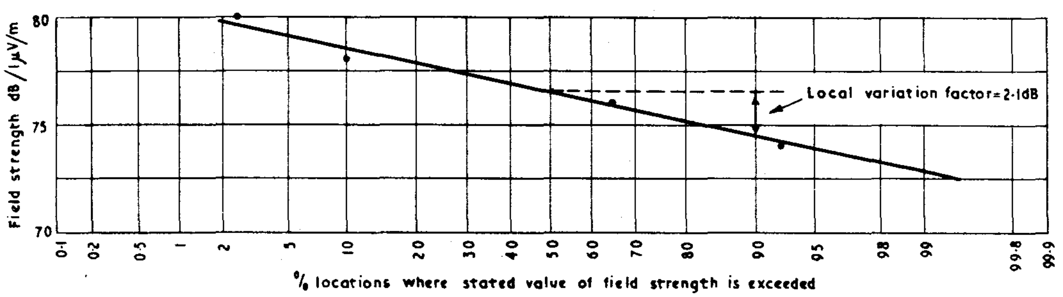

Fig. 6 - Field strength variations in open flat country. Values obtained from 1·25 mile (2km) cruise along Newark to Grantham road between Balderton and Long Bennington

Fig. 6 represents the field strength distribution in a stretch of very flat open country between Newark and Grantham and it will be seen that the local variation factor is approximately 2 dB.

In the built-up area of the adjoining town of Newark the local variation factor is approximately 6 dB, as shown in Fig. 7.

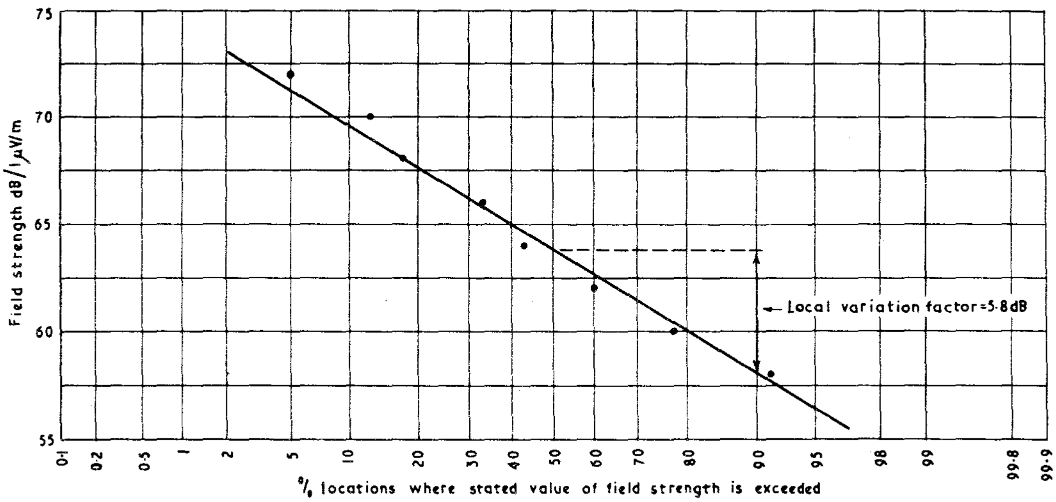

Fig. 7 - Field strength variations in built up area. Values obtained from 1·25 mile (2km) cruise through Newark

3.3. Multipath Interference.

The two most important factors in determining the degree of multipath interference ("ghosts") at any location within the service area of a television transmitter are the number of echoes received and their amplitudes relative to the direct signal. Echoes become most apparent as "ghosts" when the delay time is greater than about 2 μsec and become somewhat disturbing when the amplitude is greater than $\frac{1}{10}$ of the direct signal. The interference is defined as "serious" in Band III when there are *at least two echoes* of amplitude greater than $\frac{1}{3}$ that of the direct signal. The areas where this occurs in the principal towns are shown shaded in Figs. 2, 3 and 4 and in these areas it will be difficult or impossible to overcome the effect of the interference by the use of directional receiving aerials.

In Sheffield (Fig. 2), where many areas are severely screened in the direction of Holme Moss and the direct signal is highly attenuated, multipath interference occurred due to reflection from surrounding hills. Echoes were observed with delay times of up to 40 μsec suggesting reflecting objects at distances of 4 miles (6·5 km) or more. In the city centre and industrial area echoes from large buildings, factory chimneys and cooling towers, etc., were prominent but were not usually serious unless the reflecting objects were within about 0·2 miles (0·32 km) of the receiving site. In such cases, however, the delays would be not greater than 2 μsec.

In Manchester (Fig. 3) the median field strength would be greater than 2 mV/m in all areas and multipath interference is very much less serious than in Sheffield. Nevertheless there are some small areas where interference would be serious. In the central area echoes were mainly due to reflections from large buildings. In the eastern area the echoes were caused by a large gas works installation and in the area indicated north of Salford adjacent hills were responsible for some serious echoes.

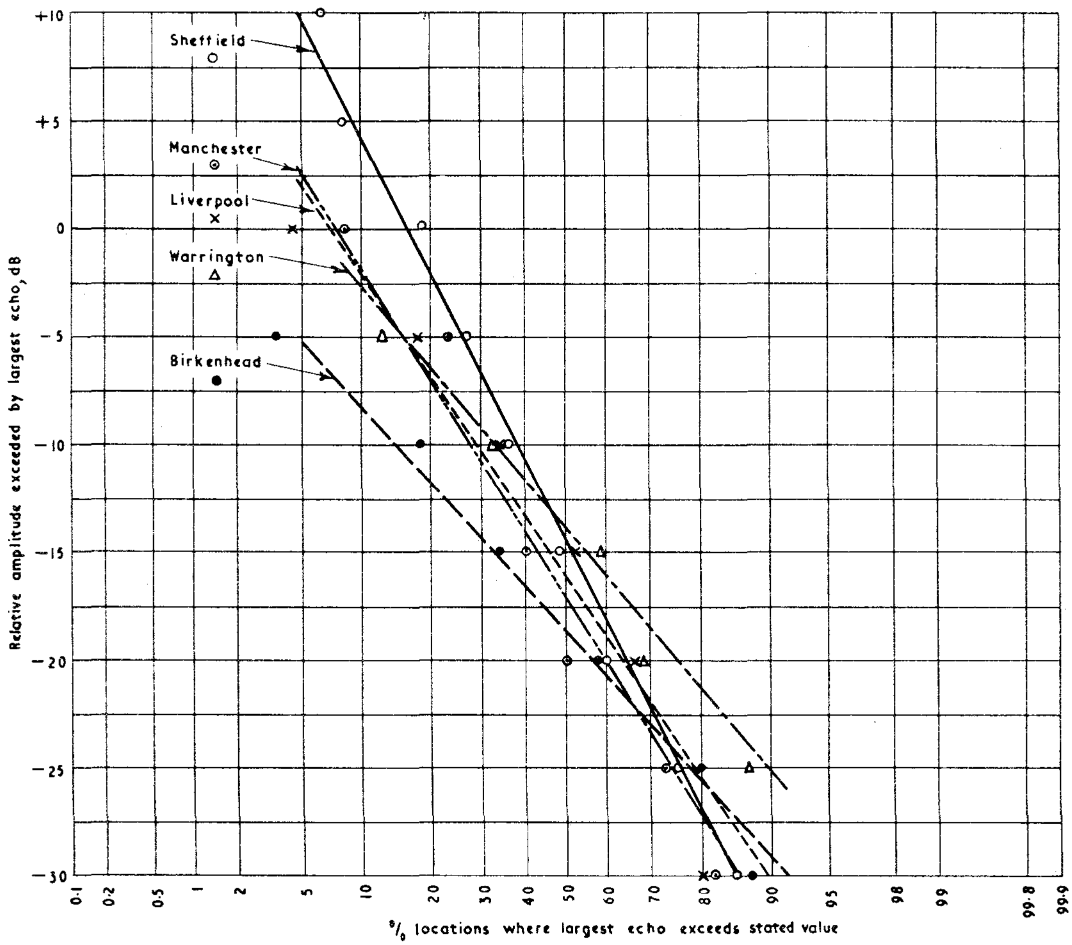

Fig. 8 - Comparison of amplitude of echoes on Band III in various towns

In Liverpool (Fig. 4) most of the areas would receive a median field strength greater than 0·5 mV/m although in parts of the city centre and dock area the field strength would fall below 0·2 mV/m. It is in these areas that multipath interference was serious. The echoes were mainly caused by reflections from large buildings and dock installations, such as cranes, but some echoes with delay times of 10–20 μsec originated in the Birkenhead area. In the dock area of Birkenhead echoes were serious due to erections at the docks but this area was comparatively small.

Although the foregoing results show only areas where echoes would be serious it is of interest to show the number of echoes and the relative amplitudes which can be expected and this information is given graphically in Figs. 8 and 9. The analyses are derived from observations of up to 70 locations in each town and the sites were taken at random and represent all types of location in each town.

Fig. 8 shows the percentage of sites where the relative amplitude of the largest echo to the direct signal exceeds the stated value. This gives some idea of the percentage of population who would need to use directional aerials to avoid multipath interference.

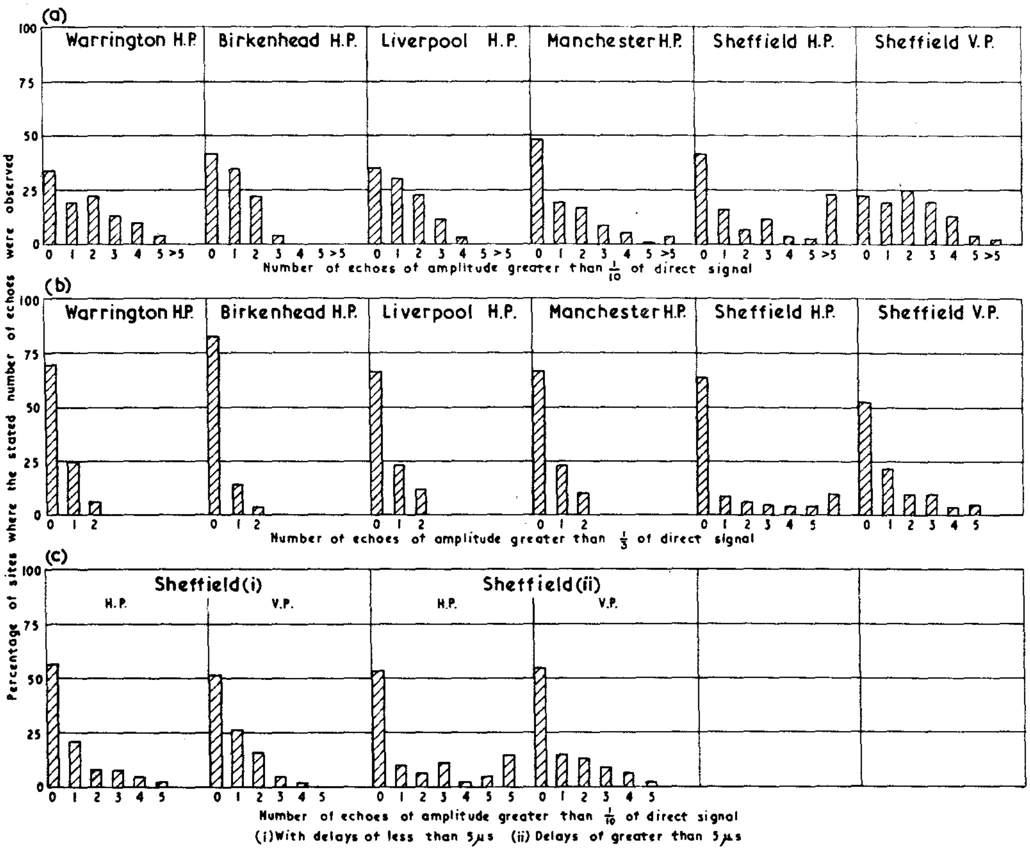

Fig. 9

Fig. 9 shows in histogram form the percentage of locations in a number of towns where the stated number of echoes of amplitude greater than $\frac{1}{10}$ and $\frac{1}{3}$ of the direct signal were present. These are shown in Sections (a) and (b) respectively. Examination of the figures shows that in all these towns, except Sheffield, there was a negligible number of locations where more than three echoes of relative amplitude greater than $\frac{1}{10}$ of the direct signal were present. Only in Sheffield were there locations where more than two echoes of amplitude greater than $\frac{1}{3}$ of the direct signal were present. Section (c) of Fig. 9 analyses the results obtained in Sheffield so as to show the number of echoes observed having delays of more or less than 5 μsec. This is discussed further in 4.2.

4. COMPARISON BETWEEN HORIZONTAL AND VERTICAL POLARISATION.

The whole of the field strength survey was made using horizontally polarised transmission but in one sector (122° ± 25°) measurements were repeated using vertically polarised transmission. This sector included the city of Sheffield and field strength and multipath interference measurements were repeated at all previous sites used for horizontal polarisation measurements.

4.1. Measurements in Towns.

The comparison of field strengths using the two polarisations is shown in Table 2.

TABLE 2

Field Strength in mV/m at 30 ft (9·2 m) a.g.l.
E.R.P. 100 kW

Town	Vertical Polarisation			Horizontal Polarisation		
	Max.	Mean	Min.	Max.	Mean	Min.
Barlborough	70	25	8·0	30	20	5·0
Chapeltown	6·0	2·0	0·9	6·0	2·0	0·7
Clowne	50	15	5·0	50	12	2·5
Conisbrough	35	4·0	1·0	50	5·5	1·0
Deepcar	80	30	10	70	30	10
Dore	1·1	0·65	0·25	1·5	0·5	0·2
Dronfield	2·0	0·7	0·25	3·0	0·7	0·2
Eckington	3·0	1·1	0·5	3·0	1·0	0·4
Gainsborough	12	5·0	1·9	20	3·5	0·6
Grantham (Centre)	2·0	0·65	0·25	2·0	0·5	0·1
Hathersage	6·0	2·5	0·9	4·0	1·5	0·3
Horncastle	1·2	0·35	0·15	1·3	0·25	0·05
Hoyland	150	65	25	250	90	20
Lincoln (South)	3·0	1·5	0·5	5·0	1·5	0·4
Lincoln (Centre)	2·0	1·1	0·5	3·0	0·7	0·2
Lincoln (N.W.)	25	8·0	2·0	40	10	2·0
Lincoln (North)	10	4·0	2·0	20	5·0	1·5
Lincoln (N.E.)	3·0	1·8	1·0	6·0	2·5	1·0
Lincoln (East)	2·0	1·0	0·55	2·5	1·1	0·5
Mexborough	38	12	3·5	50	12	3·0
Newark (East and Centre)	8·0	2·5	1·1	6·5	1·5	0·35
Ollerton	20	6·5	2·2	20	10	2·0
Oughtibridge	5·0	2·2	1·0	3·0	1·0	0·3
Sleaford	1·8	0·35	0·12	1·6	0·3	<0·1
Swinderby	12	7·0	3·0	14	8·0	3·0
Wath-upon-Dearne	70	12	3·0	40	8·0	1·5
Woodhall Spa	3·0	1·5	0·6	3·0	0·8	0·25
Worksop (S.W.)	18	8·0	3·0	15	7·0	2·0

To illustrate the comparison the results of Table 2 have been plotted as a value of vertical/horizontal polarisation for maximum, mean and minimum values and are shown in Fig. 10.

From Fig. 10 it will be seen that for 50% of the towns there is little difference in the mean value but the minimum value is higher on vertical polarisation and the maximum value lower. Thus in this particular sector, although the median values are the same, the range from maximum to minimum is likely to be higher on horizontal polarisation.

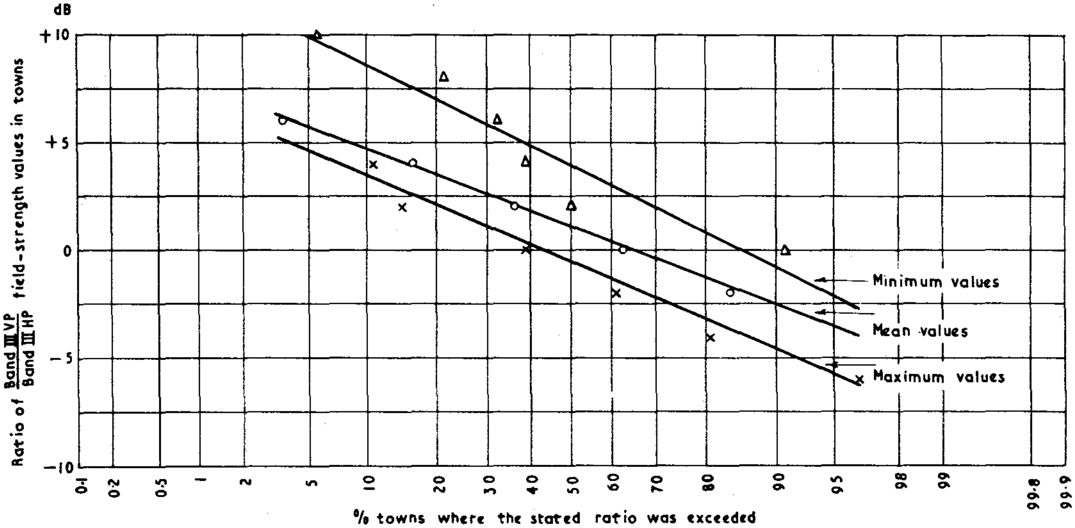

Fig. 10 - Comparison of maximum, mean and minimum values of field strength for vertically and horizontally polarised transmissions in Band III

In Sheffield the mean values for both polarisations were the same and the field strength distribution shown in Fig. 2 holds for both polarisations. However the extreme values of median field strength for vertical polarisation were 0·22 and 100 mV/m whereas the extreme values for horizontal polarisation were 0·16 and 160 mV/m. In other words, the range of median values is compressed for vertical polarisation.

In general, therefore, the field strength on horizontal polarisation tends to be higher when the town or village is on a hill and lower if in a valley or in "shadow" from the transmitter. This tends to explain why in the case of a large town, such as Sheffield which includes both hills and valleys, the mean value for the whole town is the same, in spite of the "compression" of the extreme values for vertical polarisation.

4.2. Multipath Interference.

Comparison of observations of multipath interference in Sheffield on horizontal and vertical polarisation showed that roughly the same areas would suffer severe interference and the relative amplitude of the largest echoes received would be of the same order. Detailed examination of the pulse pattern however showed that the echoes with short delay times (mostly from buildings and man-made objects within about 0·5 miles (0·8 km) of the receiving site) were slightly more pronounced when using vertical polarisation. Echoes with delays greater than 5 μsec were more severe when using horizontal polarisation. These facts are illustrated in Fig. 9(c). The observations may be partly explained by the predominance of vertical objects (cooling towers, chimneys, etc.) capable of producing echoes which are serious only when the distance of the reflecting object is small, whereas the surrounding hills are likely to receive a greater field strength with horizontal polarisation and so reflect more energy with that polarisation than with vertical polarisation.

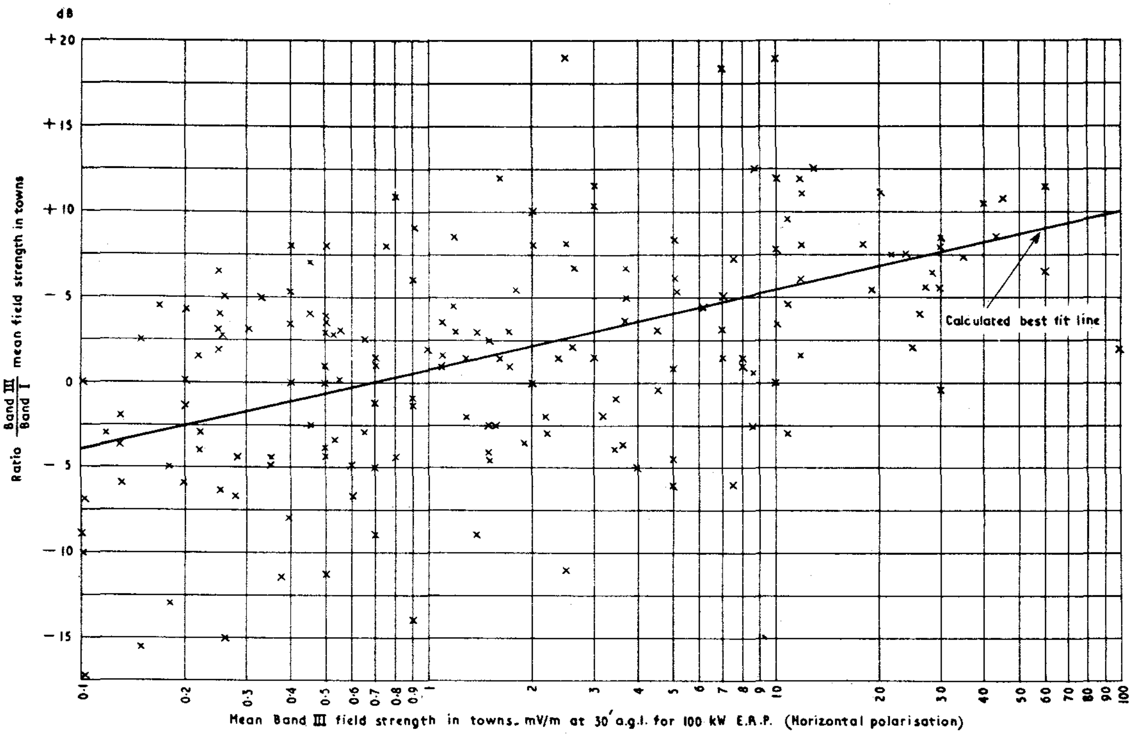

Fig. 11 - Comparison of field strength values on Band I and Band III

4.3. Horizontal/Vertical Polarisation Discrimination of Receiving Aerials.

To obtain a measure of the horizontal polarisation to vertical polarisation discrimination in a built-up area using a simple receiving dipole a short cruise of approximately one mile (1·6 km) was made in Sheffield during the period of vertically polarised transmission. The cruise was repeated with the receiving dipole oriented in the horizontal plane and, comparing the two cruises, it was found that a discrimination of at least 14 dB was obtained.

5. COMPARISON BETWEEN BAND I AND BAND III

5.1. Service Area.

As the Band III experimental aerial was on the same mast at Holme Moss as the Band I television aerial, although lower by approximately 35 ft (10·6 m), a comparison can be made between the service areas in the two bands for an e.r.p. normalised to 100 kW.

If the ratios of the median values on Band III to that on Band I in various towns are plotted against the median values on Band III a curve can be drawn as shown in Fig. 11. Although there is wide scatter in the results it can be seen that in the average case this ratio is greater than unity when the Band III field strength is higher than approximately 0·7 mV/m, assuming an e.r.p. of 100 kW.

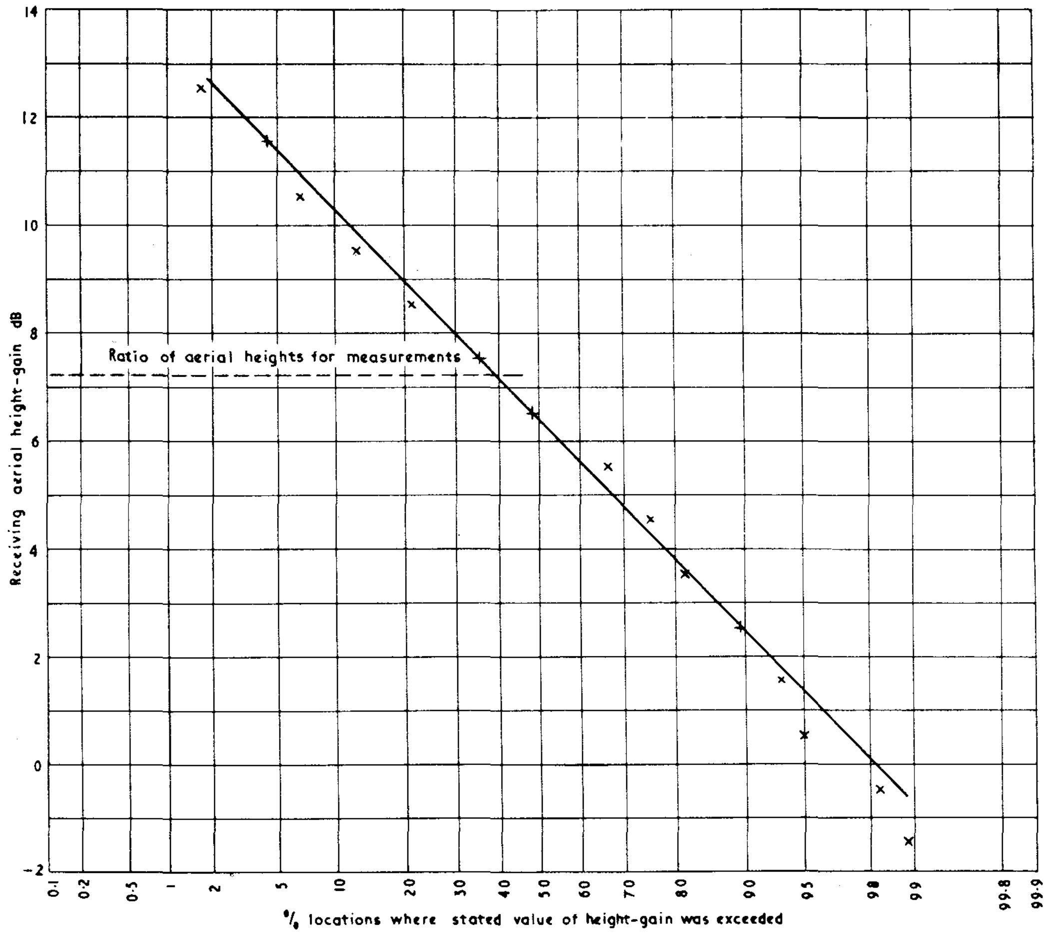

Fig. 12 - Variation of values of receiving aerial height-gain (for increase in height from 11'5" to 26'6") 181 samples in towns in the service area

In other words, if the contour map shown in Fig. 1 is compared with a Band I contour map[1] then it can be said that the area within the 0·5 mV/m is likely to receive a higher median field strength on Band III than on Band I.

The variation of field strength from maximum to minimum in towns was usually much greater on Band III than on Band I. The range of variation on Band III was, on average, 14 dB more than on Band I.

5.2. Multipath Interference.

An attempt has been made to compare the multipath interference measured during this survey with the measurements taken some years ago on Band I[2].

Only in Sheffield was it possible to make a valid comparison. It was found that in most areas where echoes were observed on Band I the relative amplitude of the largest echo was 6–10 dB less than on Band III.

6. RECEIVING AERIAL HEIGHT GAINS.

As stated in section 2 of this report, all measurements taken during the field strength survey were at 11 ft 5 in. (3·5 m) and a proportional height gain was in general applied to correct for measurements quoted at 30 ft (9·2 m). To justify this correction a large number of measurements was made each involving a short cruise of approximately 50 yds (46 m) at each location with the receiving aerial at 11 ft 5 in. (3·5 m) above ground level and then again at 26 ft 6 in. (8·1 m) above ground level (limiting height of mast). The ratio of the mean level of the signals obtained was taken to be the receiving aerial height gain for that site. These height-gain measurements are plotted in Fig. 12 which was derived from 181 samples taken in towns. The ratio of the aerial heights gave a height gain of 7·2 dB assuming direct proportionality and it will be seen that at 50% of the locations the measured height gain was within 1 dB of the value. At 98% of the locations the height gain was positive.

An example of the variation in height gain over a 1 mile (1·6 km) cruise in open country is given in Fig. 13. Although wide variation in height gain occurs from point to point the mean height gain was proportional to the ratio of the aerial heights.

From these measurements it was therefore assumed that a proportional height gain can be taken when correcting field strength measurements taken at 11 ft 5 in. (3·5 m) for a receiving aerial height of 30 ft (9·2 m).

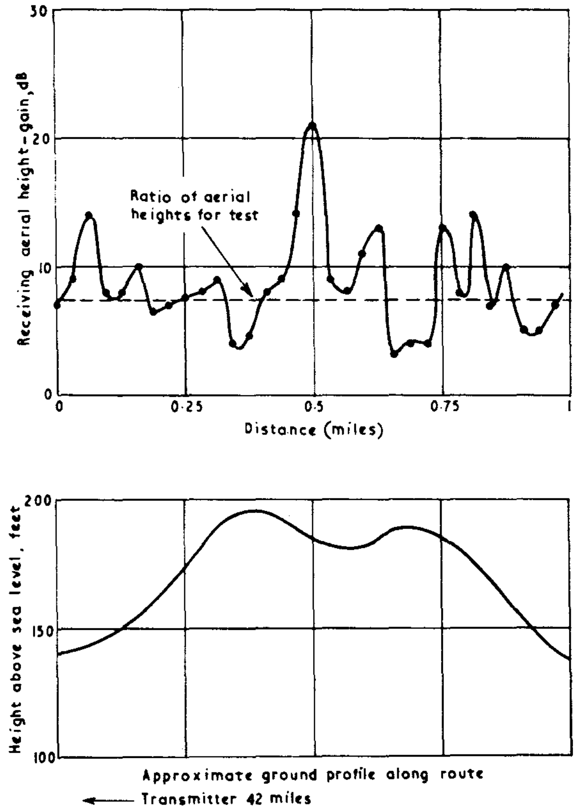

Fig. 13 - Variations of receiving aerial height-gain in open country

7. CONCLUSIONS.

A Band III transmitter sited at Holme Moss with an e.r.p. of 100 kW would serve the North of England and approximately 90% of the population would be within the 0·5 mV/m field strength contour. Because of the larger field strength variations on Band III any viewers within this contour who, owing to local variations, receive a poor service at present on Band I might expect reception on Band III to be worse.

Multipath interference would be severe in some areas, particularly in large cities and towns in hilly areas, and could be expected to be worse than on Band I. Care would have to be taken in the erection of directional receiving aerials but as, owing to the smaller physical size of Band III aerials, highly directional aerials can be more easily erected, the interference might be more easily eliminated.

8. REFERENCES.

1. Research Department Report No. K-095 (1954/2). "The Service Area of the Holme Moss Transmitter".

2. Research Department Report No. K-086 (1952/4). "Investigation of Television Service from Holme Moss in Sheffield".

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